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APPENDIX I

SUBSTITUTE SPECIFICATION

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ELECTRIC ENERGY STORAGE DEVICE

BACKGROUND OF THE INVENTION

FIELD OF INVENTION

The present invention relates to an electric energy storage device, more particularly, to a capacitor of which internal electric resistance between electrodes and their terminals is greatly reduced by increasing the contact area between the electrodes and terminals using irregular interfaces.

DISCUSSION OF RELATED ART

Elecrical energy can be stored in an electric energy storage device. The storage device such as a battery, an electrolytic condenser, a double-layered electric condenser or the like can supply an external load with the stored electric energy for operation. When the stored electrical energy is applied by the electric energy storage device to the external load, the amount of the electrical energy supplied greatly depends on the internal resistance of the storage device. Fig. 1A shows the stacked electrodes of an electric energy storage device such as a capacitor according to the prior art, and Fig. 1B shows a cylindrical electric energy storage device formed by rolling the device in Fig. 1A, thus illustrating both the stacked and rolled electrodes.

Fig. 2A shows the stacked electrodes of an electric energy storage device having a plurality of terminals according to the prior art, and Fig. 2B shows a cylindrical electric energy storage device formed by rolling the device in Fig. 2A, thus illustrating both the stacked and rolled electrodes.

Referring to Fig. 1A, an electrode body 110 includes a film type anode electrode 100, a film type

cathode electrode 102, an anode terminal 104 connected to the anode electrode 100, and a cathode terminal 106 connected to the cathode electrode 102. The film type anode electrode 100 and the film type cathode electrode 102 are stacked and isolated from each other by an insulating film (not shown in the drawing).

The anode and cathode electrodes 100 and 102 are formed as films to store electrical energy. The insulating layer inserted between the electrodes 100 and 102 isolates the anode electrode 100 from the cathode electrode 102. The anode terminal 104 is connected to the anode electrode 100 by welding or riveting, and the cathode terminal 106 is also connected to the cathode electrode 102 by the same method.

Referring to Fig. IB, a cylindrical electric energy storage device 110 is obtained by rolling up the electrode body 110 having the above structure.

The anode and cathode terminals 104 and 106 attached to the anode and cathode electrodes 100 and 102 protrude out of the electrode body 100 so as to transfer the electric energy to the external load.

Another electric energy storage device having a pair of terminals connected to a plurality of corresponding lead wires, so as to reduce the internal electric resistance generated between terminals and relatively-long electrodes, according to the prior art, will be explained by referring to Figs. 2A and Figs. 2B.

Referring to Fig. 2A, an electrode body 208 includes a film type anode electrode 200, a film type cathode electrode 202 stacked on the anode electrode 200, an insulating film(not shown in the drawing) inserted between the anode and cathode electrodes 200 and 202, a first to a third lead wire 204a, 204b, and 204c connected to the anode electrode 200 by welding or riveting at regular intervals, and a first to a third cathode lead wire 206a, 206b, and 206c connected to the cathode electrode 202 by welding or riveting at regular intervals. Namely, the first to third

anode and cathode lead wires 204a, 204b, 204c, 206a, 206b, and 206c are separated from one another at predetermined intervals.

A cylindrical electric energy storage device is provided by rolling up the electrode body 208 as shown in Fig. 2B.

Referring to Fig. 2B, the first to third anode lead wires 204a, 204b, and 204c are coupled by welding them together. Then, the welded first to third anode lead wires are connected to an anode terminal 210 by welding.

The first to third cathode lead wires 206a, 206b, and 206c are coupled by welding them together. Then, the welded first to third cathode lead wires are connected to a cathode terminal 212 by welding.

Therefore, the first to third anode and cathode lead wires 204a/204b/204c, and 206a/206b/206c are connected to the anode and cathode terminals 210 and 212, respectively.

On the other hand, the first to third anode and cathode lead wires 204a, 204b, 204c, 206a, 206b, and 206c can be connected to the corresponding terminals 210 and 212 respectively by rivet joints as well.

Fig. 3 shows a regular polygon type electric energy storage device according to the prior art, illustrating its terminal connections.

Referring to Fig. 3, a plurality of rectangular film type anode electrodes 300 and cathode electrodes 302 are stacked alternatively, and a plurality of insulating films(not shown in the drawing) are inserted between the anode and cathode films 300 and 302, respectively. A plurality of anode and cathode lead wires 308 and 310 are formed by extending predetermined ends of the anode and cathode electrodes 300 and 302 so as to huddle up in different corners to be coupled with an anode terminal 304 and a cathode terminal 306, respectively. Namely, the lead wires 308 and 310 to be connected to the corresponding terminals may be built in bodies of the electrodes 300 and 302.

In the above-structured electric energy storage device, the anode and cathode lead wires 308 and 310 of the anode and cathode electrodes 300 and 302 are connected to the anode and cathode terminals 304 and 306 by welding or riveting.

Methods of connecting a plurality of cells in an electric energy storage device by jointing anode and/or cathode terminals according to the related art will be explained as follows by referring to fig. 4 and Fig. 5.

Fig. 4 shows a schematic view of an electric energy storage device using a multi-cell method according to the prior art, and Fig. 5 shows a schematic view of an electric energy storage device using a bipolar method according to the prior art.

Referring to Fig. 4, anode and cathode terminals + and - of a plurality of electrode bodies 400-1, 400-2, 400-3,... in an electric energy storage device are connected in series using lead wires 402 or plate type conductors 402.

Referring to Fig. 5, anode electrodes 500 are separated from cathode electrodes 502 by insulating layers 504 so as to connect in series a plurality of stacked electrode bodies in an electric energy storage device.

Unfortunately, the electric energy storage device according to the prior art, as shown in Fig. 1a and Fig. 1b, when the anode and cathode electrodes are connected by welding or riveting a single anode terminal and a single cathode terminal, fails to reduce the electrical resistance between the electrodes and terminals because the resistance is proportional to the length and inversely proportional to the contact area.

In the electric energy storage device according to the prior art, as shown in Fig. 2a, Fig. 2b and Fig. 3, a plurality of lead wires are connected to the anode and cathode electrodes of the electrode body to increase the contact area between the electrode body and the anode and cathode terminals by welding. The lead wires are again connected to the anode and cathode terminals by welding or riv ting.

Thus, the electric energy storage device according to the prior art may somewhat r duce the electrical resistance between the electrodes and terminals due to the reduced electrode length of each terminal. Yet, the prior art requires more complicated fabrication method, thereby decreasing productivity.

Moreover, the electric energy storage device according to the prior art has to connect the terminals to the lead wires one by one or stack the electrode bodies one on one with insulators therebetween when a plurality of storage cells are connected by the terminal connection method of the prior art.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an electric energy storage device that substantially obviates one or more of the problems due to limitations and disadvantages of the prior art.

The object of the present invention is to provide an electric energy storage device that reduces the internal electrical resistance between electrodes and their terminals by improving the connections between the electrode body comprising anode and cathode electrodes and their respective anode/cathode terminals.

Another object of the present invention is to provide an electric energy storage device of which serial connections between a plurality of storage cells is achieved with ease.

Additional features and advantages of the invention will be set forth in the description which follows and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by

the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, the present invention, which is inserted in a housing charged with an electrolyte solution, includes at least one electrode body formed by rolling up an anode electrode, a first insulating film, a cathode electrode and a second insulating film, wherein a first protrusion of the anode electrode protrudes from one end of the electrode body and a second protrusion of the cathode electrode protrudes from the other end of the electrode body and wherein the first insulating film isolates the anode electrode from the cathode electrode except the first and second protrusions, an anode terminal connected to the first protrusion of the anode electrode wherein a first contact-extending part is formed at a bottom of the anode terminal, and a cathode terminal connected to the second protrusion of the cathode electrode wherein a second contact-extending part is formed at a bottom of the cathode terminal.

Preferably, the device further includes a metal layer formed on surfaces of the first and second protrusions.

Preferably, a pressure adjusting means such as a rubber packing is inserted between the housing and the anode and cathode terminals so as to maintain a predetermined constant pressure between the electrode body and the anode and cathode terminals.

Preferably, inlets for injecting the electrolyte are formed at each center of the anode and cathode terminals and wherein a plurality of grooves crossing each other are formed at the bottom surfaces of the anode and cathode terminals.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the inventing and together with the description serve to explain the principle of the invention. In the drawings:

Fig. 1A shows the stacked electrodes of an electric energy storage device such as a capacitor according to the prior art;

Fig. 1B shows a cylindrical electric energy storage device formed by rolling the device in Fig. 1A;

Fig. 2A shows the stacked electrodes of an electric energy storage device having a plurality of terminals according to the prior art;

Fig. 2B shows a cylindrical electric energy storage device formed by rolling the device in Fig. 2A.

Fig. 3 shows a regular polygon type electric energy storage device according to the prior art;

Fig. 4 shows a schematic view of an electric energy storage device using a multi-cell method according to a related art;

Fig. 5 shows a schematic view of an electric energy storage device using a bipolar method according to the prior art;

Fig. 6 shows the stacked electrodes in an electric energy storage device according to the present invention;

Fig. 7 shows a cylindrical electric energy storage device according to the present invention;

Fig. 8A shows a bottom view of the terminal in Fig. 7;

Fig. 8B shows a lateral cross-section of the terminal in Fig. 8A;

Fig. 9 shows a cross-sectional view of an electric energy storage device inserted in a housing according to the present invention;

Fig. 10 shows a lower part of a terminal having an electrolyte drift path, in an electric energy storage device according to the present invention;

Fig. 11A and Fig. 11B show an electric energy storage device in which terminals are formed on the same lateral side of an electrode body according to the present invention; and

Fig. 12 shows serial connections of an electric energy storage device according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Fig. 6 shows the stacked electrodes in an electric energy storage device according to the present invention, Fig. 7 shows a cylindrical electric energy storage device according to the present invention, Fig. 8A shows a bottom view of the terminal in Fig. 7. and Fig. 8B shows a lateral cross-section of the terminal in Fig. 8A.

Referring to Fig. 6, an electrode body 610 includes a film type anode electrode 600, a first

insulating film 602, a film type cathode electrode 604, and a second insulating film 606. In this case, the film type anode electrode 600, first insulating film 602, film type cathode electrode 604, and second insulating film 606 are stacked in that order, from top to bottom.

The anode electrode 600 and cathode electrode 604 are aligned to provide offset areas such that one end of the anode electrode 600 and the opposite end of the cathode electrode 604protrude out of the electrode body 610.

The reason the anode and cathode electrodes 600 and 604 are stacked to provide the offset areas is that an anode terminal 700 in Fig. 7 is to be contacted with one end of the anode electrode 600 and that a cathode terminal 702 in Fig. 7 is to be connected to the other end of the cathode electrode 604 in the electrode body 610.

In this embodiment, the first insulating film 602 is formed to isolate the anode cathode 600 from the cathode electrode 604 when stacking the films, while the second insulating film 606 is used for insulation between the anode and cathode electrodes 600 and 604 when rolling up the electrode body 610 to provide a roll type electrode body.

Referring to Fig. 7, the electrode body 610 is rolled up to form a roll type electric energy storage device providing high capacity. Then, an anode terminal 700 a cathode terminal 702 are connected to one end and the other end, respectively, of the electrode body 610 which is rolled up. In this case, the anode and cathode terminals 700 and 702 are placed over the respective ends and then pressed mechanically with a predetermined force so as to be connected to the electrode body 610.

In this case, the predetermined one end of the electrode body 610 is the offset area of the anode electrode 600 protruding out of the electrode body 610 to be connected to the anode terminal 700, while the other end of the electrode body 610 is the other offset area of the cathode electrode 604 protruding out of the electrode body 610 to be connected to the cathode terminal 702.

The anode and cathode terminals 700 and 702 contacted by the above-mentioned method will be explained in detail by referring to Fig. 8A and Fig. 8B as follows.

Referring to Fig. 8a, the anode terminal 800 has a shape of a circle covering the entire top surface of the predetermined one end of the cylindrically-rolled electrode body 610. The bottom of the anode terminal 700 contacted with the anode electrode 600 has an uneven surface having a shape of a plurality of screw threads. Thus, a vertical cross-sectional view of the anode terminal 700 is shown in Fig. 8b.

Theecathode terminal 702 has the same configuration as the anode terminal 700.

Thus, the bottoms of the anode and cathode terminals 700 and 702 of the electric energy storage device according to the present invention each have a plurality of thread-like unevennesses. Therefore, the contact areas between the anode and cathode terminals 700 and 702 and the anode and cathode electrodes 600 and 604 are increased by the plurality of the unevennesses enabling contact with the lateral sides of the offset areas of the rolled anode and cathode electrodes 600 and 604 even though the protruding ends of the electrode body 610 might fail to be rolled up uniformly.

In the present embodiment, the anode and cathode terminals 700 and 702 may be made of the same material as the anode and cathode electrodes 600 and 604. For example, the anode terminal and the cathode terminal are made of Al and Cu respectively in a lithium ion battery using an Al foil having a stable characteristic on an oxidizing potential as an anode electrode and a Cu foil having a stable characteristic on a reducing potential as a cathode electrode.

In a Ni-H battery using nickel or stainless steel showing a stable characteristic in an electrolyte solution, anode and cathode terminals are made of nickel or stainless steel.

Further, the anode and cathode terminals 700 and 702 may be made of Al, stainless steel,

Ni, Cu or the like considering chemical stability, cost and the like.

Moreover, in the electric energy storage device according to the present invention, the anode and cathode terminals 700 and 702 can be connected to metal layers formed by plasma or arc spray on the terminal contact areas of the anode and cathode electrodes 600 and 604 of the electrode body 610 so as to reduce resistance by increasing the contact areas between the anode and cathode terminals 700 and 702 and electrodes 600 and 604.

The electrode body 610 to which the terminals are connected by the above-described method is inserted into a housing, as shown in Fig. 9, thereby completing the electric energy storage device according to the present invention.

Fig. 9 shows a cross-sectional view of an electric energy storage device inserted in a housing according to the present invention.

Referring to Fig. 9, an electrode body 906 to which the above-mentioned anode and cathode terminals 902 and 904 are connected is installed in a housing 900 made of metal, molding resin or the like. A pressure adjusting means 908 is placed between the housing 900 and the anode and cathode terminals 902 and 904, thereby buffering the pressure applied to the electrode body 906 due to the anode and cathode terminals 902 and 904. In this case, the pressure adjusting means 908 may be made of an elastic rubber packing. And, the housing 900 is charged with an electrolyte solution 910.

When a liquid electrolyte solution 910 is used for the electric energy storage device, gases may be produced during operation. The contact pressure between the electrode body 906 and the anode and/or cathode terminals 902 and/or 904 may vary because of housing expansion due to the increased temperature of the device itself or ambient conditions. Moreover, the contact resistance between the electrode body 906 and the anode and/or cathode terminals 902 and/or 904 may vary due to long-term use.

Therefore, the above-structured electric energy storing means keeps the contact pressure stable between the electrode body 906 and the anode or cathode terminal 902 or 906 because the elasticity of the rubber packing acts as a pressure adjusting means 908 to reduce the expansive force.

Fig. 10 shows the bottom of a terminal having an electrolyte drift path in an electric energy storage device according to the present invention.

Referring to Fig. 10, a pair of cross type grooves 912 are formed on the bottom of a terminal having an electrolyte drift path in an electric energy storage device.

In addition, a charging hole 914 for charging the housing 900 with the electrolyte solution 910 is formed at the intersection of the grooves 912.

The above-structured electric energy storage device according to the present invention enables carrying out electrolyte charging by flowing the electrolyte into the housing through the charging hole 914 using the grooves 912 as an electrolyte drift path after the electrode body has been installed in the housing.

The above-structured electric energy storage device according to the present invention enables expulsion of gas generated when using the device through the charging hole 914.

Fig. 11A and Fig. 11B show an electric energy storage device in which the anode and cathode terminals are formed at the same lateral side(end) of the electrode body according to the present invention.

An electric energy storage device according to the present invention enables formation of anode and cathode terminals at the same lateral side of the electrode body.

As shown in Fig. 11 A, a thread-like unevenness is formed at a lower internal surface of a housing 922 which is contacted with a lower side of an electrode body 920. The electrode body 920 is installed in the housing 922. An anode terminal 924 as shown in Fig. 8A and Fig. 8B is

connected to an upper part of the electrode body 920. Thus, a cathode terminal 926 is formed at the same direction as the anode terminal 924 on the housing 922.

Referring to Fig. 11b, an anode terminal 930 and a cathode terminal 932 are connected respectively by the terminal connection method of the present invention. Then, the cathode terminal 932 is placed at the same direction as the anode terminal 930 by connecting a lead wire 934 to the cathode terminal 932.

Fig. 12 shows serial connections of an electric energy storage device according to the present invention.

Referring to Fig. 12, a serial connection is formed in which an anode terminal 940 of an electrode body is contacted with a cathode terminal 942 of an adjacent electrode body is respectively achieved by inserting a plurality of electrode bodies 944, to each of which an anode terminal 940 and a cathode terminal 942 are connected, into a housing 946 in a line. In this case, a reactive gas is expelled to the outside of the electric energy storage device by installing anti-explosive valves 948 between the contacting anode and cathode terminals 940 and 942.

In an electric energy storage device according to the present invention, an anode electrode and a cathode electrode are stacked to have offset areas with predetermined margins and an insulating film is inserted between the anode and cathode electrodes. The stacked electrodes between which the insulating film is inserted are rolled up. Then, an anode terminal and a cathode terminal which have the same shape as the bottom/top of the roll type electrodes and have thread-like unevennesses are mechanically connected to the top and bottom of the respective rolled electrode bodies by applying a predetermined force thereto.

Accordingly, an electric energy storage device according to the present invention reduces the electric resistance between the electrodes and terminals by minimizing the current path in the electrodes.

In addition, an electric energy storage device according to the present invention reduces the internal electric resistance effectively by increasing the contact areas between the electrodes and terminals because of a plurality of the thread-like unevenness formed at the bottoms of the terminals.

Further, an electric energy storage device according to the present invention reduces the contact resistance therebetween by contacting the anode and cathode terminals with a metal layer formed on the anode and cathode electrodes by metal spray.

Further yet, an electric energy storage device according to the present invention avoids the malfunction of the device due to the separation between the electrodes and terminals by keeping the contact pressure between the terminals and the electrode body using a rubber packing inserted between the housing and the terminals.

Moreover, an electric energy storage device according to the present invention improves the device efficiency by forming a charging hole and grooves at the anode and cathode terminals so as to provide easy and uniform electrolyte injection.

Furthermore, an electric energy storage device according to the present invention achieves a serial connection with ease by inserting a plurality of roll type electrode bodies in a housing such that the anode electrodes are respectively contacted with the cathode electrodes by a single electrode inserted between the electrode bodies.

It will be apparent to those skilled in the art that various modifications and variations can be made in an electric energy storage device of the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and equivalents.

APPENDIX II

MARKED-UP SPECIFICATION

ELECTRIC ENERGY STORAGE DEVICE

BACKGROUND OF THE INVENTION

FIELD OF INVENTION

The present invention relates to an electric energy storage device, more particularly, to a capacitor of which internal electric resistance between electrodes and their terminals is greatly reduced by increasing the contact area between the electrodes and terminals using irregular interfaces.

DISCUSSION OF RELATED ART

~~Supplied electric~~Electrical energy ~~is~~can be stored in an electric energy storage device. ~~And~~ The storage device such as a battery, an ~~electrolyte~~ electrolytic condenser, a double-layered electric condenser or the like ~~supplies~~ can supply an external load with the stored electric energy for operation. When the stored electrical energy is applied by the electric energy storage device to the external load, the amount of the ~~supplied~~ electrical energy supplied greatly depends on ~~their own~~the internal resistance of the storage device. Fig. 1A shows ~~a bird's-eye view of~~ the stacked electrodes of an electric energy storage device such as a capacitor according to ~~a related~~the prior art, and Fig. 1B shows ~~a bird's-eye view of~~ a cylindrical electric energy storage device formed by rolling the device in Fig. 1A, ~~for~~ thus illustrating both the stacked and rolled electrodes.

Fig. 2A shows ~~a bird's-eye view of~~the stacked electrodes of an electric energy storage device having a plurality of terminals according to ~~a related~~the prior art, and Fig. 2B shows ~~a bird's-eye view of~~ a cylindrical electric energy storage device formed by rolling the device in Fig. 2A, ~~for~~ thus illustrating both the stacked and rolled electrodes.

Referring to Fig. 1A, an electrode body 110 includes a film type anode electrode 100, a film type

cathode electrode 102, an anode terminal 104 connected to the anode electrode 100, and a cathode terminal 106 connected to the cathode electrode 102. ~~And, the~~The film type anode electrode 100 and the film type cathode electrode 102 are stacked and isolated from each other by an insulating film (not shown in the drawing).

The anode and cathode electrodes 100 and 102 are formed ~~with~~ as films to store ~~electrons~~ electrical energy. The insulating layer inserted between the electrodes 100 and 102 isolates the anode electrode 100 from the cathode electrode 102. The anode terminal 104 is connected to the anode electrode 100 by welding or riveting, and the cathode terminal 106 is also connected to the cathode electrode 102 by the same method.

Referring to Fig. 1B, a cylindrical electric energy storage device 110 is ~~attained~~ obtained by rolling up the electrode body 110 having the above structure.

The anode and cathode terminals 104 and 106 attached to the anode and cathode electrodes 100 and 102 protrude out of the electrode body 100 so as to transfer the electric energy to the external load.

Another electric energy storage device having a pair of terminals connected to a plurality of corresponding lead wires, so as to reduce the internal electric resistance generated between terminals and relatively-long electrodes, according to ~~a related~~the prior art, will be explained by referring to Figs. 2A and Figs. 2B~~ so as to reduce the internal electric resistance generated between terminals and relatively-long electrodes~~.

Referring to Fig. 2A, an electrode body 208 includes a film type anode electrode 200, a film type cathode electrode 202 stacked on the anode electrode 200, an insulating film(not shown in the drawing) inserted between the anode and cathode electrodes 200 and 202, a first to a third lead wire 204a, 204b, and 204c connected to the anode electrode 200 by welding or riveting ~~with~~at regular ~~constant~~ intervals~~ apart~~, and a first to a third cathode lead wire 206a, 206b, and 206c connected to the cathode electrode 202 by welding or riveting ~~with constant~~ at regular

intervals~~ apart~~. Namely, the first to third anode and cathode lead wires 204a, 204b, 204c, 206a, 206b, and 206c are separated from one another ~~with~~ at predetermined intervals ~~apart~~.

A cylindrical electric energy storage device is provided by rolling up the electrode body 208 as shown in Fig. 2B.

Referring to Fig. 2B, the first to third anode lead wires 204a, 204b, and 204c are coupled by welding ~~all in one~~them together. Then, the welded first to third anode lead wires are connected to an anode terminal 210 by welding.

The first to third cathode lead wires 206a, 206b, and 206c are coupled by welding ~~all in one~~them together. Then, the welded first to third cathode lead wires are connected to a cathode terminal 212 by welding.

Therefore, the first to third anode and cathode lead wires 204a/204b/204c, and 206a/206b/206c are connected to the anode and cathode terminals 210 and 212, respectively.

On the other hand, the first to third anode and cathode lead wires 204a, 204b, 204c, 206a, 206b, and 206c can be connected to the corresponding terminals 210 and 212 respectively by rivet joints as well.

Fig. 3 shows ~~a bird's-eye view of~~ a regular polygon type electric energy storage ~~devide~~ device according to ~~a related~~ the prior art, ~~in~~ illustrating its terminal connections.

Referring to Fig. 3, a plurality of rectangular film type anode electrodes 300 and cathode electrodes 302 are stacked alternatively, and a plurality of insulating films(not shown in the drawing) are inserted between the anode and cathode films 300 and 302, respectively. A plurality of anode and cathode lead wires 308 and 310 are formed by extending predetermined ends of the anode and cathode electrodes 300 and 302 so as to huddle up in different corners to be coupled with an anode terminal 304 and a cathode terminal 306, respectively. Namely, the lead wires 308 and 310 to be connected to the corresponding terminals may be built in bodies of the electrodes 300 and 302.

In the above-~~structure,~~ structured electric energy storage device, the anode and cathode lead wires 308 and 310 of the anode and cathode electrodes 300 and 302 are connected to the anode and cathode terminals 304 and 306 by welding or riveting.

Methods of connecting a plurality of cells in an electric energy storage device by jointing anode and/or cathode terminals according to the related art will be explained as follows by referring to fig. 4 and Fig. 5.

Fig. 4 shows a schematic view of an electric energy storage device using a multi-cell method according to ~~a related~~ the prior art, and Fig. 5 shows a schematic view of an electric energy storage device using a bipolar method according to ~~a related~~the prior art.

Referring to Fig. 4, anode and cathode terminals + and - of a plurality of electrode bodies 400-1, 400-2, 400-3,... in an electric energy storage device are connected in series using lead wires 402 or plate type conductors 402.

Referring to Fig. 5, anode electrodes 500 are separated from cathode electrodes 502 by insulating layers 504 so as to connect in series a plurality of stacked electrode bodies in an electric energy storage device.

Unfortunately, the electric energy storage device according to the ~~related~~ prior art, as shown in Fig. 1a and Fig. 1b, when the anode and cathode electrodes are connected by welding or riveting a single anode terminal and a single cathode terminal, fails to reduce the electrical resistance ~~generated~~ between the electrodes and terminals because the resistance is proportional to the length and inversely proportional to the contact area.

~~And, in~~In the electric energy storage device according to the ~~related~~ prior art, as shown in Fig. 2a, Fig. 2b and Fig. 3, a plurality of lead wires are connected to the anode and cathode electrodes of the electrode body to increase the contact area between the electrode body and the anode and cathode terminals by welding. ~~And, the~~ The lead wires are again connected to the anode and cathode terminals by welding or riveting.

Thus, the electric energy storage device according to the ~~related~~ prior art may somewhat reduce the electrical resistance between the electrodes and terminals due to the reduced electrode length of each terminal. Yet, the ~~related~~ prior art requires more complicated fabrication method, thereby decreasing productivity.

Moreover, the electric energy storage device according to the ~~related~~ prior art has to connect the terminals to the lead wires one by one or stack the electrode bodies one on one with insulators therebetween~~.~~ when a plurality of storage cells are connected by the terminal connection method of the ~~related~~ prior art.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an electric energy storage device that substantially obviates one or more of the problems due to limitations and disadvantages of the ~~related~~ prior art.

The object of the present invention is to provide an electric energy storage device ~~enabling to reduce~~ that reduces the internal electrical resistance between electrodes and their terminals by improving the connections between the electrode body comprising anode and cathode electrodes and ~~the~~ their respective anode/cathode terminals.

Another object of the present invention is to provide an electric energy storage device of which serial connections between a plurality of storage cells is achieved with ease.

Additional features and advantages of the invention will be set forth in the description which follows and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by

the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, the present invention, which is inserted in a housing charged with an electrolyte solution, includes at least one electrode body formed by rolling up an anode electrode, a first insulating film, a cathode electrode and a second insulating film, wherein a first protrusion of the anode electrode protrudes from one end of the electrode body and a second protrusion of the cathode electrode protrudes from the other end of the electrode body and wherein the first insulating film isolates the anode electrode from the cathode electrode except the first and second protrusions, an anode terminal connected to the first protrusion of the anode electrode wherein a first contact-extending part is formed at a bottom of the anode terminal, and a cathode terminal connected to the second protrusion of the cathode electrode wherein a second contact-extending part is formed at a bottom of the cathode terminal. Preferably, the device further includes a metal layer formed on surfaces of the first and second protrusions.

Preferably, a pressure adjusting means such as a rubber packing is inserted between the housing and the anode and cathode terminals so as to maintain a predetermined constant pressure between the electrode body and the anode and cathode terminals.

Preferably, inlets for injecting the electrolyte are formed at each center of the anode and cathode terminals and wherein a plurality of grooves crossing each other are formed at the bottom surfaces of the anode and cathode terminals.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the inventing and together with the description serve to explain the principle of the invention. In the drawings:

Fig. 1A shows ~~a bird's-eye view of~~the stacked electrodes of an electric energy storage device such as a capacitor according to ~~a related~~the prior art;

Fig. 1B shows ~~a bird's-eye view of~~ a cylindrical electric energy storage device formed by rolling the device in Fig. 1A~~ for illustrating the stacked and rolled electrodes~~;

Fig. 2A shows ~~a bird's-eye view of~~the stacked electrodes of an electric energy storage device having a plurality of terminals according to ~~a related~~the prior art;

Fig. 2B shows ~~a bird's-eye view of~~ a cylindrical electric energy storage device formed by rolling the device in Fig. 2A~~ for illustrating the stacked and rolled electrodes~~.

Fig. 3 shows ~~a bird's-eye view of~~ a regular polygon type electric energy storage ~~devide~~ device according to ~~a related~~the prior art~~ for illustrating terminal connections~~;

Fig. 4 shows a schematic view of an electric energy storage device using a multi-cell method according to a related art;

Fig. 5 shows a schematic view of an electric energy storage device using a bipolar method according to ~~a related~~the prior art;

Fig. 6 shows ~~a bird's-eye view of~~ the -stacked electrodes in an electric energy storage device according to the present invention;

Fig. 7 shows a cylindrical electric energy storage device according to the present invention;

Fig. 8A shows a bottom view of ~~a~~ the terminal in Fig. 7;

Fig. 8B shows a lateral cross-section of the terminal in Fig. 8A;

Fig. 9 shows a cross-sectional view of an electric energy storage device inserted in a housing according to the present invention;

Fig. 10 shows a lower part of a terminal having an electrolyte drift path, in an electric energy storage device according to the present invention;

Fig. 11A and Fig. 11B show an electric energy storage dovice ~~of~~ in which terminals are formed ~~in~~ on the same lateral side of an electrode body according to the present invention; and

Fig. 12 shows serial connections of an electric energy storage device according to the present invention.

~~Major parts designated by numerals~~

~~600 : anode electrode 602 : first insulating layer~~

~~604 : cathode electrode 606 : second insulating layer~~

~~610 : electrode body~~

~~700 : anode terminal 702 : cathode terminal~~

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Fig. 6 shows ~~a bird's eye view of~~ the stacked electrodes in an electric energy storage device according to the present invention, Fig. 7 shows a cylindrical electric energy storage device according to the present invention, Fig. 8A shows a bottom view of ~~a~~ the terminal in Fig. 7. and Fig. 8B shows a lateral cross-section of the terminal in Fig. 8A.

Referring to Fig. 6, an electrode body 610 includes a film type anode electrode 600, a first

insulating film 602, a film type cathode electrode 604, and a second insulating film 606. In this case, the film type anode electrode 600, first insulating film 602, film type cathode electrode 604, and second insulating film 606 are ~~all~~ stacked in ~~reverse~~ that order, from top to bottom. ~~And, the~~ The anode electrode 600 and cathode electrode 604 are aligned to provide offset areas such that one end of the anode electrode 600 and the opposite end of the cathode electrode 604protrude out of the electrode body 610.

~~Namely, the~~ The reason ~~why~~ the anode and cathode electrodes 600 and 604 are stacked to provide the offset areas is that an anode terminal 700 in Fig. 7 is to be contacted with one end of the anode electrode 600 and that a cathode terminal 702 in Fig. 7 ~~does~~ is to be connected to the other end of the cathode electrode 604 in the electrode body 610.

In this ~~case~~ embodiment, the first insulating film 602 is formed to isolate the anode cathode 600 from the cathode electrode 604 when stacking the films, while the second insulating film 606 is used for insulation between the anode and cathode electrodes 600 and 604 when rolling up the electrode body 610 to provide a roll type electrode body.

Referring to Fig. 7, the electrode body 610 is rolled up to form a roll type electric energy storage device ~~enabling to provide~~ providing high capacity. Then, an anode terminal 700 a cathode terminal 702 are connected to one end and the other end, respectively, of the electrode body 610 which is rolled ~~respectively~~ up. In this case, the anode and cathode terminals 700 and 702 are placed over the respective ends and then pressed mechanically with a predetermined force so as to be connected to the electrode body 610.

In this case, the predetermined one end of the electrode body 610 is the offset area of the anode electrode 600 protruding out of the electrode body 610 to be connected to the anode terminal 700, while the other end of the electrode body 610 is the other offset area of the cathode electrode ~~444~~ 604 protruding out of the electrode body 610 to be connected to the cathode terminal 702.

The anode and cathode terminals 700 and 702 contacted by the above-mentioned method will be explained in detail by referring to Fig. 8A and Fig. 8B as follows.

Referring to Fig. 8a, the anode terminal 800 has a shape of a circle ~~enabling to cover~~ covering the entire top surface of the predetermined one end of the cylindrically-rolled electrode body 610. ~~And, the~~ The bottom of the anode terminal 700 contacted with the anode electrode 600 has an uneven surface having a shape of a plurality of screw threads. Thus, a vertical cross-sectional view of the anode terminal 700 is shown in Fig. 8b.

~~And, the~~ The cathode terminal 702 has the same ~~figure of~~ configuration as the anode terminal 700. Thus, the bottoms of the anode and cathode terminals 700 and 702 of the electric energy storage device according to the present invention each have a plurality of ~~the~~ thread-like unevennesses. Therefore, the contact areas between the anode and cathode terminals 700 and 702 and the anode and cathode electrodes 600 and 604 are increased by ~~a~~ the plurality of the unevennesses enabling ~~to be~~ contact~~ed~~ with the lateral sides of the offset areas of the rolled anode and cathode electrodes 600 and 604 even though the protruding ends of the electrode body 610 might fail to be rolled up uniformly.

In ~~this case~~ the present embodiment, the anode and cathode terminals 700 and 702 may be made of the same material ~~of~~ as the anode and cathode electrodes 600 and 604. For ~~instance~~ example, ~~a~~ the anode terminal and ~~a~~ the cathode terminal are made of Al and Cu respectively in a lithium ion battery using an Al foil having a stable characteristic on an oxidizing potential as an anode electrode and a Cu foil having a stable characteristic on a reducing potential as a cathode electrode.

In a Ni-H battery using nickel or stainless steel showing a stable characteristic in an electrolyte solution, anode and cathode terminals are made of nickel or stainless steel.

~~Besides~~ Further, the anode and cathode terminals 700 and 702 may be made of Al, stainless steel,

Ni, Cu or the like considering chemical stability, cost and the like.

Moreover, in the electric energy storage device according to the present invention, the anode and cathode terminals 700 and 702 can be connected to metal layers formed by plasma or arc spray on the terminal contact areas of the anode and cathode electrodes 600 and 604 of the electrode body 610 so as to reduce resistance by increasing the contact areas between the anode and cathode terminals 700 and 702 and electrodes 600 and 604.

The electrode body 610 to which the terminals are connected by the above-described method is inserted into a housing, as shown in Fig. 9, thereby completing the electric energy storage device according to the present invention.

Fig. 9 shows a cross-sectional view of an electric energy storage device inserted in a housing according to the present invention.

Referring to Fig. 9, an electrode body 906 to which the above-mentioned anode and cathode terminals 902 and 904 are connected is installed in a housing 900 made of metal, molding resin or the like. A pressure adjusting means 908 is placed between the housing 900 and the anode and cathode terminals 902 and 904, thereby buffering the pressure applied to the electrode body 906 due to the anode and cathode terminals 902 and 904. In this case, the pressure adjusting means 908 may be made of an elastic rubber packing. And, the housing 900 is charged with an electrolyte solution 910.

When a liquid electrolyte solution 910 is used for the electric energy storage device, gases may be produced during operation. ~~And, the~~ The contact pressure between the electrode body 906 and the anode and/or cathode terminals 902 and/or 904 may vary ~~by the~~ because of housing expansion due to the increased temperature of the device itself or ~~the ambience~~ ambient conditions. Moreover, the contact resistance between the electrode body 906 and the anode and/or cathode terminals 902 and/or 904 may vary due to long-term use.

Therefore, the above-structured electric energy storing means ~~enables to keep~~ keeps the contact pressure stable between the electrode body 906 and the anode or cathode terminal 902 or 906 because the elasticity of the rubber packing acts as ~~the~~ a pressure adjusting means 908 to reduce~~s~~ the expansive force.

Fig. 10 shows ~~a~~ the bottom of a terminal having an electrolyte drift path in an electric energy storage device according to the present invention.

Referring to Fig. 10, a pair of cross type grooves 912 are formed on ~~a~~ the bottom of a terminal having an electrolyte drift path in an electric energy storage device.

~~And~~ In addition, a charging hole 914 for charging the housing 900 with the electrolyte solution 910 is formed at the ~~cross section~~ intersection of the grooves 912.

The above-structured electric energy storage device according to the present invention enables ~~to~~ carrying out electrolyte charging by flowing the electrolyte into the housing through the charging hole 914 using the grooves 912 as an electrolyte drift path after the electrode body has been installed in the housing.

~~And, the~~ The above-structured electric energy storage device according to the present invention enables ~~to expel the~~ expulsion of gas generated when using the device through the charging hole 914.

Fig. 11A and Fig. 11B show an electric energy storage device ~~of~~ in which the anode and cathode terminals are formed at the same lateral side(end) of ~~an~~ the electrode body according to the present invention.

An electric energy storage device according to the present invention enables ~~to form~~ formation of anode and cathode terminals at the same lateral side of ~~an~~ the electrode body.

As shown in Fig. 11 A, a thread-like unevenness is formed at a lower internal surface of a housing 922 which is contacted with a lower side of an electrode body 920. The electrode body 920 is installed in the housing 922. An anode terminal 924 as shown in Fig. 8A and Fig. 8B i

connected to an upper part of the electrode body 920. Thus, a cathode terminal 926 is formed at the same direction ~~of~~ as the anode terminal 924 on the housing 922.

Referring to Fig. 11b, an anode terminal 930 and a cathode terminal 932 are connected respectively by the terminal connection method of the present invention. Then, the cathode terminal 932 is placed at the same direction ~~of~~ as the anode terminal 930 by connecting a lead wire 934 to the cathode terminal 932.

Fig. 12 shows serial connections of an electric energy storage device according to the present invention.

Referring to Fig. 12, a serial connection ~~that~~ is formed in which an anode terminal 940 of an electrode body is contacted with a cathode terminal 942 of an adjacent electrode body is respectively achieved by inserting a plurality of electrode bodies 944, to each of which an anode terminal 940 and a cathode terminal 942 are connected, into a housing 946 in a line. In this case, a reactive gas is expelled to the outside of the electric energy storage device by installing anti-explosive valves 948 between the contacting anode and cathode terminals 940 and 942.

In an electric energy storage device according to the present invention, an anode electrode and a cathode electrode are stacked to have offset areas with predetermined margins and an insulating film is inserted between the anode and cathode electrodes. ~~And, the~~ The stacked electrodes between which the insulating film is inserted ~~is~~ are rolled up. Then, an anode terminal and a cathode terminal which have the same shape ~~of~~ as the bottom/top of the roll type electrodes and have ~~the~~ thread-like unevennesses are mechanically connected to ~~a~~ the top and bottom of the respective rolled electrode ~~body~~ bodies ~~respectively~~ by applying a predetermined force thereto.

Accordingly, an electric energy storage device according to the present invention ~~enables to~~ reduces the electric resistance between the electrodes and terminals by minimizing ~~a~~ the current

path in the electrodes.

~~And~~In addition, an electric energy storage device according to the present invention ~~enables to~~ reduces the internal electric resistance effectively by increasing the contact areas between the electrodes and terminals because of a plurality of the thread-like unevenness formed at the bottoms of the terminals.

~~And~~Further, an electric energy storage device according to the present invention ~~enables to~~ reduces the contact resistance therebetween by contacting the anode and cathode terminals with a metal layer formed on the anode and cathode electrodes by metal spray.

~~And~~Further yet, an electric energy storage device according to the present invention ~~enables to~~ avoids the malfunction of the device due to the separation between the electrodes and terminals by keeping the contact pressure between the terminals and the electrode body ~~since~~using a rubber packing ~~is~~ inserted between the housing and the terminals.

Moreover, an electric energy storage device according to the present invention ~~enables to~~ improves the device efficiency by forming a charging hole and grooves at the anode and cathode terminals so as to provide easy and uniform electrolyte injection.

Furthermore, an electric energy storage device according to the present invention ~~enables to~~ achieves a serial connection with ease by inserting a plurality of roll type electrode bodies in a housing such that the anode electrodes are respectively contacted with the cathode electrodes by a single electrode inserted between the electrode bodies.

It will be apparent to those skilled in the art that various modifications and variations can be made in an electric energy storage device of the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and equivalents.

APPENDIX III

CORRECTED DRAWINGS

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FIG. 1A

(PRIOR ART)

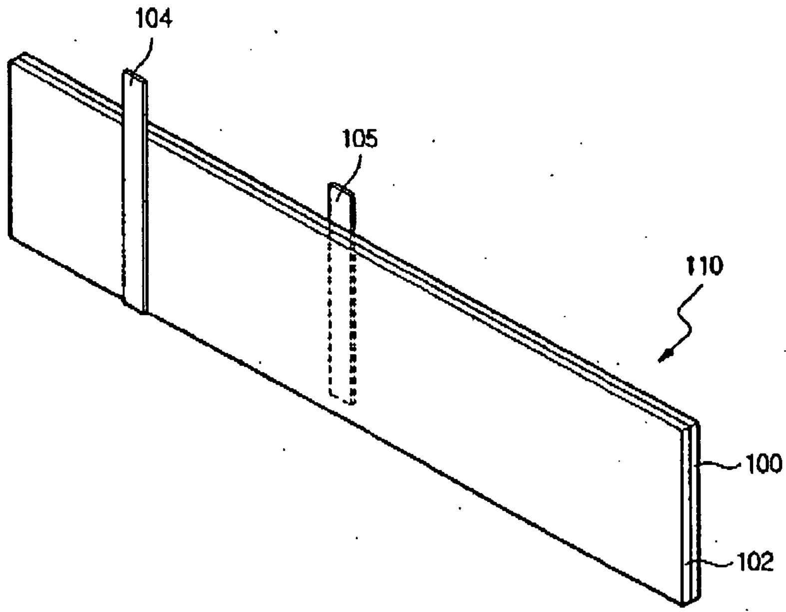

FIG. 1B

(PRIOR ART)

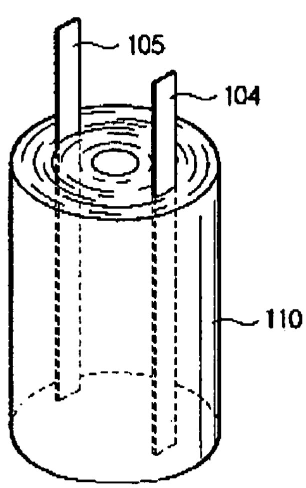

FIG. 2A

(PRIOR ART)

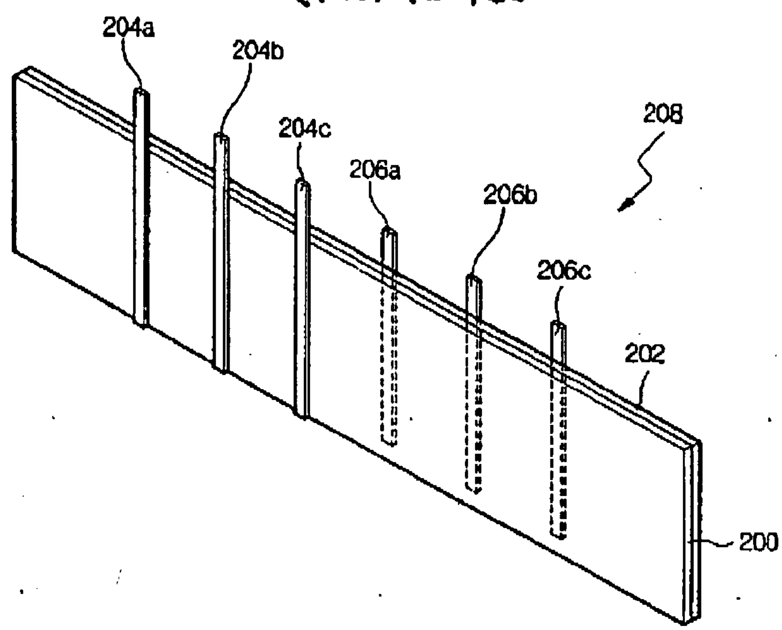

FIG. 2B

(PRIOR ART)

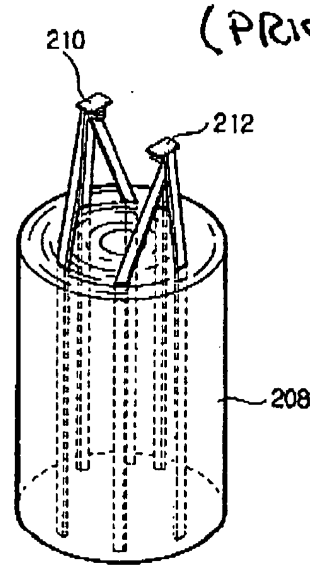

FIG. 3 (PRIOR ART)

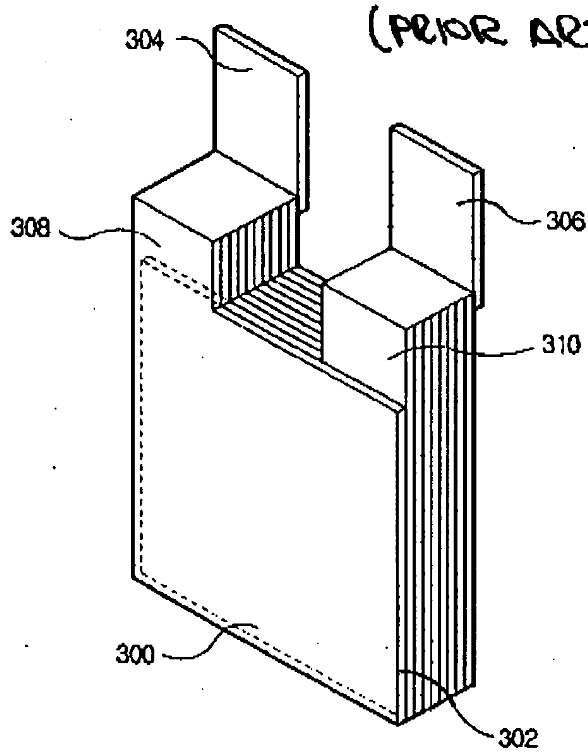

FIG. 4 (PRIOR ART)

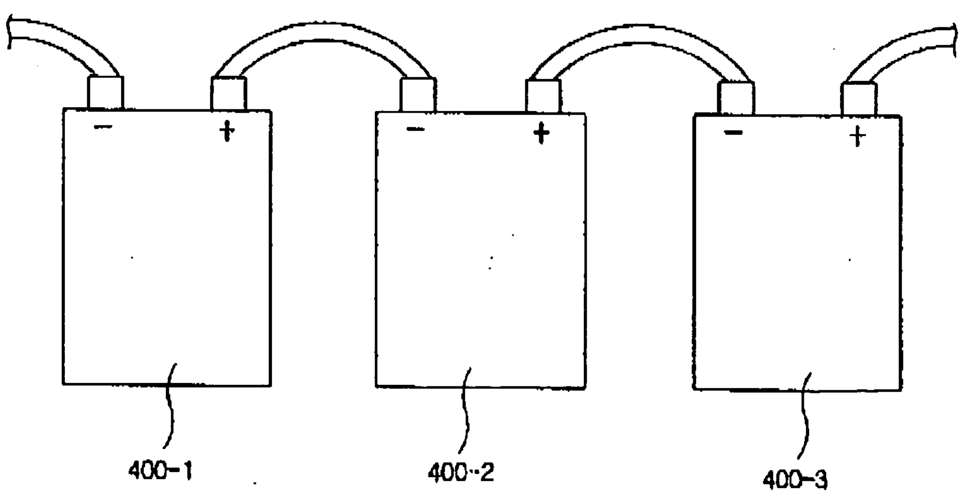

FIG. 5

(PRIOR ART)